THREE-DIMENSIONAL, FLEXIBLE, REPEATEDLY AND DURABLY FORMABLE KNITTED FABRIC AND PROCEDURE FOR ITS MANUFACTURE

The invention described here deals with a three-dimensional, flexible, repeatedly and durably formable knitted fabric and a procedure for the manufacture of this fabric.

The invention described is intended to meet a need for a knitted fabric which can be deformed to take on three-dimensional shapes by a simple mechanical treatment, such as manually or by pulling it over a solid shape. This need is met by a knitted fabric as per Claim 1 and a procedure as per Claim 7. Further advantageous applications of this invention are dealt with in the Subclaims.

The knitted fabric invented contains a single-strand polymer fiber of a certain strength, preferable of at least 50 DEN (Denier), which, together with a number of other fibers, preferably viscose fibers, are coarsely knitted using shifting and right stitches. In other words, after finishing one stitch row on both needle beds with right stitches (right/right), the needle beds are shifted relative to one another, which can be achieved by shifting one of the needle beds to the left or right, preferably by one stitch. The right/right stitch chosen for the knitted fabric has the advantage that it results in a minimum of crossovers in the stitch and also that this stitch naturally produces the long stitch sides required. The combination of stitch, the use of a single-strand polyamide or polyester yarn and of knitting with a shift all results in the material desired.

The knitted fabric is very loosely knitted, i.e., with 7 stitches per inch, or preferably even more loosely with 5 stitches per inch. The thread feed is set to be very loose in order to produce loose stitches, and the removal is set to be more taut in order to avoid problems when finishing the loose stitches. However, the knitted fabric could also be knitted with a finer stitch, e.g., 12 stitches per inch.

This stitch and manufacturing procedure result in a material that can be deformed into other forms with a minimum of working, and which can easily be reverted to its original shape, even by hand, without changing the material structure. Thus the material can be deformed, over and over again (an almost infinite number of times), into various forms.

Single-strand polymer fiber made out of polyamide or polyester is preferably used; it has a high elasticity and contributes significantly to the reversibility of deformations. The single-strand polymer thread should preferably have a strength of between 50 and 500 DEN, ideally between 100 and 400 DEN. Best results are obtained with a strength lying between 125 and 350 DEN. A strength in this range is best for the 'returning to shape' property of the polymer single strand and, together with the stitch structure, thus leads to the formability and the reversibility of the formability of the knitted fabric.

Viscose threads are used as additional threads, which lend the knitted fabric the desired texture and appearance. Viscose yarn also minimizes the 'hard' and synthetic feel of nylon. The viscose yarn used alongside the single-strand polyamide or polyester yarn determines the color and is itself available in many colors. A filament yarn consisting of a number of fibers is used, which is loosely spun and thus has a more bulky and voluminous feel than nylon fiber. Such a material is well-suited for clothing. The fine and smooth viscose yarn has a radiant quality and thus enhances the appearance of the yarn.

By coating the viscose yarn with the carrier fiber, a homogenous appearance of the knitted fabric is created and the workability of the yarn when knitting is improved.

The knitted fabric invented is particularly suited for the creation of individual fashion collections, including sportswear and leisure wear, as well as for decorative elements in the home or for practical items, such as for offices or cars. It can also be used for technical applications such as the manufacture of filter units or as a support in mold making – e.g., bodywork, sporting goods (chassis parts, snowboards), for medical uses, or as a support for foils/fleece. When using the material as a support in mold making, it is best to set the three-dimensionally formed material in a plastic matrix. Alternatively or as an additional prior step, the three-dimensional form can also be fixed by thermoforming, whereby a thermo-fiber or melt fiber is either used as a carrier fiber or is included in the stitch. The three-dimensional knitted fabric can also be ad-

vantageously used as a coating material for pipes and cables; in this case, setting in a plastic or rubber matrix may be necessary. The knitted fabric can also be used as a filter medium.

It is also possible to knit the three-dimensionally formable knitted fabric invented – either in combination or in series – with conventional two-dimensional fabrics, particularly for the fashion branch, e.g., shoes. In this case, one can knit for a defined number of rows with the stitch structure required, which can then be formed three-dimensionally, and then knit another part in single-layer form, e.g., right/left or only on the right/left needle bed. Three-dimensional forms can thus freely be combined with flat structures, resulting in a large number of possible applications, especially in fashion and design.

The stitch structure proposed here demands multiple layers, which is yielded by the right/right stitch, but can also be created by a left/left or other stitch which allows for a shifting of the stitches of one row relative to other rows. A right/right (RR) stitch does not necessarily have to be used in the knitted fabric invented; however, a right/right stitch was found to be the most effective for creating a reversible three-dimensional structure.

The knitted fabric can be produced on conventional flat knitting machines, particularly on two-bed or four-bed machines.

Both the coated and uncoated stitched viscose fiber can be replaced by all other commercially available yarns, spun yarn, filament yarn, single threads, combined yarns or twines. Of course, the carrier fiber does not have to be a pure polymer fiber; it can also contain natural fibers. A number of fibers can also be used instead of a carrier fiber, and a number of viscose fibers can also be used instead of just one viscose fiber.

The shifting of the needle beds between rows is best realized by holding one needle bed stationary while the other needle bed in the series is shifted alternately to the right and then to the left by one stitch. The beds can, however, both be shifted relative to each other, if the knitting machine allows this. If shifting of needle beds relative to each other is used, it must be ensured that the relative shift does not exceed two needle stitches.

The knitted fabric can be fixed into a three dimensional shape after forming by thermofixing, for example, whereby the fabric is thermally and/or chemically treated, after which the fabric is fixed. This can be achieved by means of melt threads or other thermally or chemically treatable threads. Alternatively or additionally, the fabric can be fixed by adding another material or by setting in another material, e.g., latex or plastic. This technique is particularly suitable for all types of mold making.

The invention is explained in the figures which follow. They show:

Fig. 1 A representation of the stitch pattern of the fabric.

Fig. 2 A schematic representation of the needle beds and of the course of the thread in the basic arrangement.

Fig. 3 A schematic representation of the stitch pattern of the finished fabric as per Figure 1.

Figure 1 shows a fabric which was knitted on a two-bed flat knitting machine. Item 1 indicates the stitches of the rear needle bed which appear as left stitches when viewed from the rear; Item 2 indicates the stitches of the front stitch bed which appear in this representation as right stitches. The fact that the 'shifted' stitches in the various stitch rows appear diagonally shows the shifting of the stitch rows relative to one another.

The generation on a two-bed flat knitting machine of the stitch shown in Figure 1 is shown in Figure 2. Item 1 in Figure 2 A shows the front needle bed and Item 2 shows the rear needle bed. Item 3 indicates the course of the thread; it can be seen here that right stitches are being knitted on both beds.

Figure 2 B shows the stitch pattern on both beds in the next row. In this row, the rear needle bed has been shifted by one needle stitch to the right relative to the front needle bed. Figure 2 C shows the stitch pattern in the subsequent rows; it can be observed that the needles of the rear bed have been shifted by a further needle stitch, so that the original position of the beds relative to one another (as per Figure 2 A) has been reached again. In this manner, the shifting of

stitches in adjacent rows as shown in Figures 1 and 3 is created; this shifting, together with the polymer fibers used, yields the formability and the reversibility of the formability of the fabric.

In this manner, the fabric illustrated in Figure 1 is generated. This fabric, with a padded extra fiber in a larger area of the knitting, is to be seen in Figure 3.

For the purpose of clarity, only the carrier fiber has been shown in Figure 1. Additional threads, such as viscose threads, can of course also be included. Other synthetic or, preferably, natural materials, e.g., cotton or wool, could also be included (coated) with the carrier thread.